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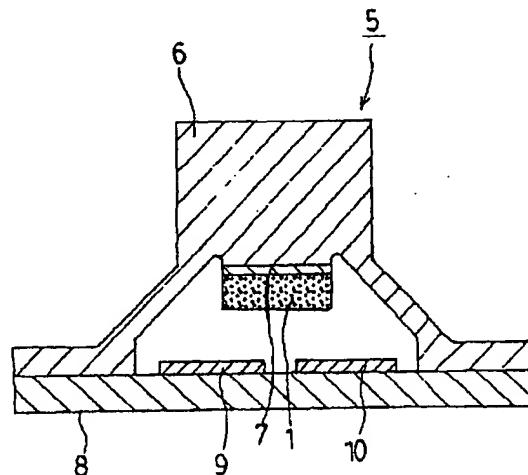
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(54)【発明の名称】 感圧可変抵抗器

(57)【要約】

【目的】 キーボードスイッチ等に容易に応用できる可変抵抗器を提供する。

【構成】 カーボンブラックやグラファイト等の炭素粉末をシリコンゴム材に混合し、一体成形して感圧可変抵抗器1を成形する。この感圧可変抵抗器1を、例えばスイッチ5に応用する場合は、キートップ6の下面に導電層7を介して感圧可変抵抗器1を設ける。キートップ6を押下げる時、感圧可変抵抗器1が固定接点9、10に当接する。押圧力によって炭素粉末間の接触圧が高まり、固定接点9、10と導電層7を導通させる異方性導電作用が表われる。押圧力に対応して感圧可変抵抗器1の抵抗値が変化し、固定接点9、10間の電圧を任意に手動操作できる。



産できる。そして、摆動子をもたないソリッド形なのでキーボードやコントローラ等への適用が容易であり、可変抵抗器の応用範囲が拡大されて、種々のエレクトロニクス機器の機能向上に寄与できる。

【図面の簡単な説明】

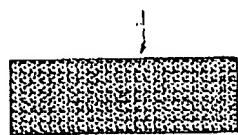
- 【図1】本発明の感圧可変抵抗器の正面図。
- 【図2】感圧可変抵抗器の作用を示す解説図。
- 【図3】応力と本発明の感圧可変抵抗器の抵抗値との関係を表わす解説グラフ。
- 【図4】感圧可変抵抗器を使用したスイッチの断面図。
- 【図5】図4のスイッチのオン状態における電流経路を

示す解説図。

【符号の説明】

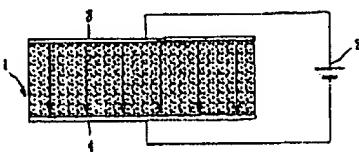
1	感圧可変抵抗器
2	電源
3, 4	電極
5	スイッチ
6	ラバーキートップ
7	導電層
8	回路基板
9, 10	固定接点

【図1】

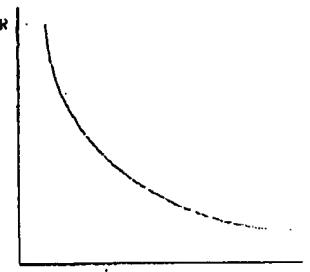


【図4】

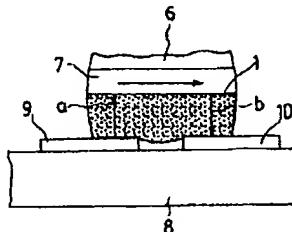
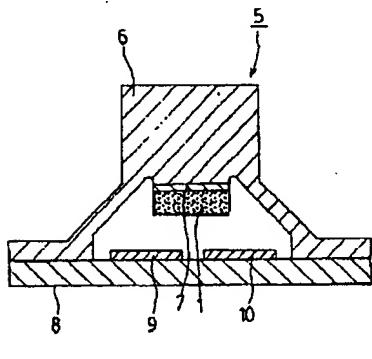
【図2】



【図3】



【図5】



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Examination Apply No Number of claims 1 (total 3 pages)				
(21) Appl. No. Patent Application H04-121993 (22) Filing date May 14, 1992		(71) Applicant 000006220 Mitsumi Electric., Ltd. 8-8-2 Kokuryo-cho, Chofu-shi, Tokyo (72) Inventor Hitoshi Furukawa Hainesu Byura 101 541 Kotta, Tama-shi, Tokyo (72) Inventor Yoshihiro Hirao Hayagiri-so 3 2-19-13 Kokuryo-cho, Chofu-shi, Tokyo (74) Representative Koukishi Hayashi, Patent Attorney		

(54) [Title of the invention] Pressure-sensitive variable resistor

(57) [Abstract]

[Objective] To provide a variable resistor that can easily be applied to keyboards and the like.

[Construction] A pressure-sensitive variable resistor 1 is formed by mixing carbon powder such as carbon black and graphite with a silicon rubber material and integrally molding it. For applying it, for example, to a switch 5, a pressure-sensitive variable resistor 1 is provided on the bottom surface of a key top 6 via an electro-conductive layer 7. When the key top 6 is pressed down, the pressure-sensitive variable resistor 1 abuts secure contact points 9 and 10. The contact pressure between carbon powder particles is increased by the applied pressure and anisotropic conductivity is established between the secure contact points 9 and 10 and the electro-conductive layer 7. The resistance of the pressure-sensitive variable resistor 1 is changed according to the applied pressure so that the voltage between the secure contact points 9 and 10 can be manually and arbitrarily controlled.

[Claim]

[Claim 1] A pressure-sensitive variable resistor formed by mixing an electro-conductive material with an elastic rubber material and integrally molding it for anisotropic conductivity.

[Detailed explanation of the invention]

[0001]

[Scope of the invention]

The present invention relates to a variable resistor, and in particular to a variable resistor having a solid structure.

[0002]

[Prior art technology]

Traditionally, variable resistors comprising a resistor and sliding contact points are used for circuit voltage adjustment. On the other hand, sensors such as straight gauges using the properties of semiconductor pressure-sensitive elements having stress related variable electric resistance are well known.

[0003]

[Problems overcome by the invention]

For example, cursor motion keys and scroll keys in computers and power window switches in automobiles are switches that simply switch between ON and OFF. If these keys and switches are provided with a function to adjust the analogue operation rate according to the intention of the operator, improvement in terms of so-called man-machine performance is anticipated.

[0004]

In order to realize this analogue operation, a variable resistor as an electric rate operating means should be installed in keys or switches while, needless to say, hardware and software must be modified. However, there are problems with volume, weight, durability, and cost in applying the prior art variable resistors to these keys and switches. For

example, when prior art mechanical variable resistors are used in the keys of a keyboard, problems occur with space, durability, and operability.

[0005]

Therefore, the purpose of the present invention is to provide a variable resistor having a simple structure and high durability, yielding changes in resistance corresponding to operational feeling, and requiring low cost for improved functions of electronic devices.

[0006]

[Problem resolution means]

In order to achieve the above purpose, the present invention proposes a pressure-sensitive variable resistor formed by mixing an electro-conductive material such as carbon powder with an elastic rubber material and integrally molding it for anisotropic conductivity.

[0007]

[Efficacy]

An electro-conductive substance such as carbon powder mixed in the elastic rubber material normally exhibits low contact pressure between the electro-conductive substances, yielding high electric resistance. When the elastic rubber is pressured on both sides, the elastic rubber is deformed by the stress and has increased contact pressure between the electro-conductive substances in the stress direction, decreasing the resistance and establishing anisotropic conductivity in the stress direction. The resistance is changed in proportion to the stress. The change in load stress is easily translated to the change in resistance.

[0008]

## [Embodiment]

An embodiment of the present invention is described in detail hereafter with reference to the drawings. Fig.1 shows a pressure-sensitive variable resistor 1 formed by mixing an elastic rubber material such as silicon rubber with carbon powder such as carbon black and graphite and molding it into a rubber plate having appropriate thickness. As shown in Fig.2, electrodes 3 and 4 of a power source 2 are connected to the pressure-sensitive variable resistor 1 on either side. Then, stress is applied to either side of the pressure-sensitive variable resistor 1. Consequently, the contact mode of the carbon powder in the stress direction is changed and anisotropic conductivity in the arrowed direction is established.

## [0009]

Fig.3 shows the relationship between stress F and resistance R. The resistance is high in the absence of stress. As the pressure is increased, the carbon powder becomes a denser contact mode in the stress direction, resulting in decreased resistance. Therefore, measurements of the voltage between the electrodes 3 and 4 provide the stress expressed in electrical quantity, which can be used, for example, in load meters. Resistors having different ranges of resistance and load power can be provided depending on the volume, cross-sectional aspect ratio, hardness, and carbon powder mixing rate of the pressure-sensitive variable resistor 1.

## [0010]

Fig. 4 shows an embodiment in which the pressure-sensitive variable resistor 1 is applied to a switch 5. Here, the pressure-sensitive variable resistor 1 is used as the movable contact point of a rubber key top 6. An electro-conductive layer 7 is provided between the pressure-sensitive variable resistor 1 and the rubber key top 6. The electro-conductive layer 7 is formed on one surface of the pressure-sensitive variable resistor 1 by printing or integral molding. When the rubber key top 6 is pressed down, the pressure-sensitive variable resistor 1 makes contact with two secure contact points 9 and 10 on a circuit board 8 as shown in Fig.5, establishing a circuit between the two secure contact points 9 and 10 via anisotropic electro-conductive paths a and b of the pressure-sensitive variable resistor 1 and the electro-conductive layer 7 above it. When the contact pressure is low,

the pressure-sensitive variable resistor 1 has high resistance. The resistance is reduced as the rubber key top 6 is further pressed down and the contact pressure is increased..

[0011]

For example, when the switch 5 is used as a component in an oscillation circuit, the oscillation frequency can be controlled depending on the pressing force. When the switch 5 is used in the scroll keys and cursor motion keys of a computer keyboard and the hardware and software is modified to change the scroll rate and cursor moving speed according to the resistance, the scroll rate, cursor moving speed, and character reaction speed in computer games can be fully controlled according the intention of the user.

[0012]

The present invention is not restricted to the above embodiment and various modifications can be made without departing from the scope of the invention. Needless to say, the present invention contains all such modifications.

[0013]

[Efficacy of the invention]

The pressure-sensitive variable resistor of the present invention is, as described in detail with regard to the above embodiment, a solid resistor that has a variable resistance according to the pressing force, which is subject to very little failures such as breaking, is excellent in productivity, and suitable for mass-production with low cost. It is a solid-type without a sliding element. Therefore, the pressure-sensitive variable resistor of the present invention can be easily applied to keyboards and controllers and contributes to extended use of variable resistors and, subsequently, improved functions of various electronic devices.

[Brief explanation of the drawings]

- [Fig.1] A plane view of the pressure-sensitive variable resistor of the present invention.
- [Fig.2] An illustration to explain the behavior of the pressure-sensitive variable resistor.
- [Fig.3] A graphical representation showing the relationship between stress and resistance of the pressure-sensitive variable resistor of the present invention.
- [Fig.4] A cross-sectional view of a switch using the pressure-sensitive variable resistor.
- [Fig.5] An illustration showing the electric path within the switch in Fig.4 when it is on.

[Legend]

- 1 pressure-sensitive variable resistor
- 2 power source
- 3,4 electrode
- 5 switch
- 6 rubber key top
- 7 electro-conductive layer
- 8 circuit board
- 9, 10 secure contact point

## CERTIFICATE OF TRANSLATION

I Roger P. Lewis, whose address is 42 Bird Street North, Martinsburg WV 25401, declare and state the following:

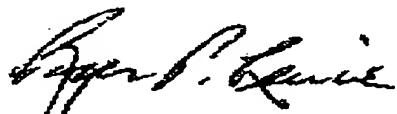
I am well acquainted with the English and Japanese languages and have in the past translated numerous English/Japanese documents of legal and/or technical content.

I hereby certify that the Japanese translation of the attached translation of documents identified as:

Laid Open Patent Application H05-326217;  
"Pressure-sensitive variable resistor"

is to the best of my knowledge and ability true and accurate.

I further declare that all statements contained herein of our own knowledge, are true, that all statements of information and belief are believed to be true.



ROGER P. LEWIS

September 26, 2006